035 Precision Voltage to Current Converter

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In measurement and control systems a common method of sending control or measurement data over long distances is by means of a ‘current loop’ using two wires. This system converts the measurement values into corresponding current levels on the two wire loop.

In such a system a precision converter is required to translate the measured values (typically in the form of a voltage level) into a current on the loop i.e. a current source controlled by a voltage.

IC1b together with T1, R5–R8 and P2 form an instrumentation amplifier, this amplifier controls the voltage across resistor R9 to ensure that it exactly follows the input voltage. Because R9 has a fixed resistance, the current through it will be exactly proportional to the voltage across it (according to Mr Ohm). The current through R9 is therefore exactly proportional to the input voltage. IC1b therefore forms the voltage controlled current source.

P2 is used to optimise the common mode rejection of this instrumentation amplifier by compensating for unequal resistances and imbalance caused by R9.

The input amplifier formed by IC1a ensures that the voltage into the instrumentation amplifier is limited and within its control range. D1, R3 and R4 add an offset to this input voltage to ensure that with 0 V input the output will be, not 0 mA but 4 mA. The maximum output current is 20 mA. This circuit is therefore a ‘20 mA current loop’ interface, often used in industrial control applications.

The amplification factor of the complete circuit is performed by IC1a and can be adjusted by preset P1. To calibrate the circuit:

1. Common mode rejection optimisation using P2:
Connect a DMM in series with a resistor of 47 Ω. Connect this to the output (in place of RL), measure the output current. Now short circuit the 47Ω resistor and measure the output current again. If there is no difference in the output current then P2 is correctly adjusted. Otherwise, adjust P2.

2. Voltage range adjustment:
With the output short-circuited, adjust P1 until 200 mV is measured across R9.

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